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(54) IMPROVEMENTS IN OR RELATING TO CONVEYOR BELTS

(57) A conveyor belt (1) made of polymeric material having a reinforcement comprising cords (2) of an aromatic polyamide extending longitudinally in the direction of the belt (1).

The cords (2) comprise strands which are twisted or laid together. The cords (2) may be heat set to increase their modulus or the strands may be heat set prior to forming the cords (2) to increase the modulus of the strands. The cords (2) are coated with an adhesive topcoat and the strands may be coated with an adhesive subcoat prior to forming the cords (2). The strands may be heat set with a predetermined twist.

The cords (2) in the belt (1) may all have the same direction of twist.

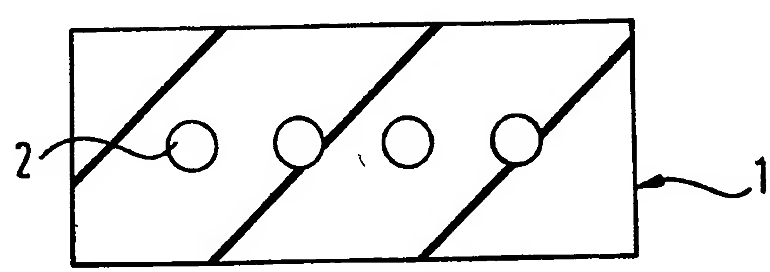

FIG. 1

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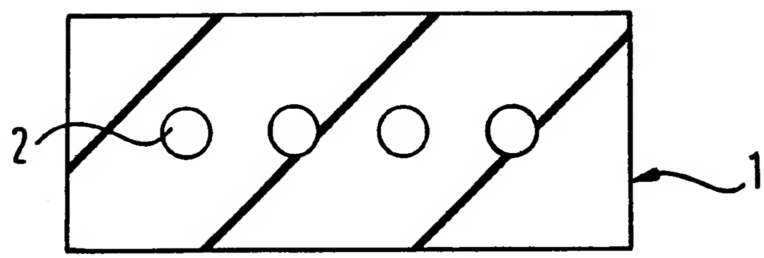

FIG. 1

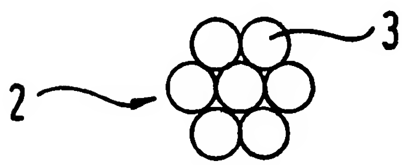

FIG. 2

SPECIFICATION

IMPROVEMENTS IN OR RELATING TO CONVEYOR BELTS

This invention concerns improvements in or relating to conveyor belts and to a method of making conveyor belts.

Conventional conveyor belting comprises polymeric material such as rubber having embedded therein a reinforcement of woven textile material or of steel cords extending longitudinally in the direction of the belting.

Textile reinforcements have strength limitations which require that a high tensile strength rated belt has to be reinforced by numerous reinforcement plies which makes the belt bulky, reduces the flexibility of the belt and also adds considerably to the cost of production. For these reasons textile reinforcements are generally only suitable for use in low tensile strength rated belts and steel cord reinforcements are preferred for use in high tensile strength rated belt.

However steel cord reinforcements have the disadvantages of increased weight, greater resistance to flexing and lower extensibility than textile reinforcements so that the belt installation has to be more robust to support the belting and to stand any snatch loads on the pulley and motor bearings.

Furthermore the manufacture of steel cord reinforced belting is more difficult and expensive than textile reinforced belting. Thus when steel cords are embedded in rubber by calendering the cords tend to displace. Also, especially during heating for vulcanisation, the steel cords expand and tend to sink in the relatively soft rubber. In order to avoid non-uniform stressing of the cords in the completed belt structure special apparatus is required to tension the cords uniformly during curing of the belt assembly and this adds to the difficult and expense of the process.

Additionally the steel cords are made by twisting individual wires together with the result that the cords are torsionally stressed and there is a tendency for the cords to unwind. As a result if all the cords in the belt have the same direction of twist the belt is unbalanced due to this tendency of the cords to unwind and belt tracking problems arise. Consequently it is necessary to ensure that alternate steel cords are of opposite twist direction in the finished belt. This complicates the assembly of the belt and, where alternate cords do not have opposite twist directions the finished belt is unbalanced and will not operate satisfactorily.

According to the present invention we provide a conveyor belt comprising a layer of polymeric material reinforced by a plurality of cords of aromatic polyamide material extending longitudinally in the direction of the belt.

Preferably the cords are laterally spaced relative to one another and the space between adjacent cords is filled with the polymeric material so that the belt is able to flex in a direction transverse to the longitudinal direction of the belt but is reinforced in the longitudinal direction.

Preferably the aromatic polyamide material comprises poly (p-phenylene terephthalamide) available as Kevlar (Registered Trade Mark), but other aromatic polyamide materials such as poly (m-phenylene isophthalamide), available as Nomex (Registered Trade Mark) may be used. Aromatic polyamides such as these provide a low density reinforcement compared to steel and, in the case of Kevlar, provide a tensile strength similar to that of steel but with a density of 0.2 times that of steel.

The cords are formed by twisting or laying two or more strands together each strand being formed from one or more yarns. The cords may be heat set to increase their modulus but preferably the strands are heat set to increase their modulus prior to forming the cords. It has been found that the modulus of cords formed from strands which have been heat set is comparable with the modulus obtained by forming the cords from strands which have not been heat set and subsequently heat setting the assembled cords. The force required to increase the modulus of the individual strands is considerably less than would be necessary to increase the modulus of the cords.

Preferably the strands are heat set with a predetermined twist such that the torsional stressing of the cords is minimal and there is little or no tendency for the cords to unwind. A balanced construction of belt can therefore be obtained using cords having the same direction of twist. Consequently the assembly of the belt is simplified as compared to belts incorporating steel cords where cords having opposite directions of twist must be used alternately.

Furthermore because there is little or no tendency for the cords to unwind a balanced construction of belt can still be obtained even if cords having opposite directions of twist are arranged in random manner.

Cords formed from an aromatic polyamide material do not exhibit the same degree of thermal expansion as steel and also have less tendency to sink in warm rubber than do steel cords. Thus it is unnecessary to maintain and accurately control the tension on the cords in the same manner as necessary for steel cords during assembly and curing of the belt and thus relatively simpler equipment can be used during assembly and curing.

Suitable polymeric materials for embedding the cords comprise natural or synthetic rubber, for example SBR or neoprene blends or suitable plastics material, for example polyvinyl chloride. The material is selected to give the belt any desired characteristics for example fire, oil, gas, water or heat resistance where appropriate.

According to a further aspect of the present invention we provide a method of manufacturing a conveyor belt comprising forming strands of an aromatic polyamide material, forming the strands

into cords and uniting the cords in a polymeric material so that the cords extend longitudinally in the direction of the assembled belt.

The strands may be formed into cords without applying an adhesive but preferably the strands are coated with an adhesive topcoat to facilitate adhesive between the adhesive subcoat on the strands on the polymeric material. Preferred adhesives for the topcoat are mixtures of a phenol, an aldehyde and latex, for example resorcinol, formaldehyde and latex.

The cords may be heat set to increase their modulus but preferably the strands are heat set to increase their modulus prior to forming the cords. The strands are preferably heat set with a predetermined twist to produce a cord having little or no tendency to unwind.

The cords may be embedded in the polymeric material by calendering curable polymeric material onto a layer of cords and then passing the assembly through a press or continuous vulcaniser to effect cure of the polymeric material.

Preferably the belt is formed by calendering two layers of polymeric material onto a layer of cords. A breaker layer may be provided on each side of the layer of cords. More than one layer of cords may be provided depending on the strength requirements of the belt. Preferably one layer of cords only is used and the diameter and spacing of the cords is selected to give the required tensile strength.

It will be appreciated from the foregoing that the present invention provides a conveyor belt in which the reinforcement can have a comparable tensile strength to steel cords but which has the advantages of lower weight compared to steel cords and increased extensibility in the longitudinal direction of the belt so that the power requirements to drive the belting is lower and also snatch loads on the pulley and motor bearings of the installation are considerably reduced.

Furthermore the manufacture of the belt according to the invention is considerably simplified in comparison with the manufacture of steel cord reinforced belting since the complicated and expensive tensioning apparatus for steel cords during assembly and curing of steel cord belt is not required and also there is no need to use cords having opposite directions of twist.

According to a further aspect of the present invention we provide a reinforcement for an article made of polymeric material comprising a cord of aromatic polyamide material in which the individual strands of the cord are heat set to increase the modulus of the strands prior to forming the cord.

Preferably the strands are heat set with a degree of twist so that there is little or no tendency for the cord to unwind.

The invention will now be described in more detail with reference to the accompanying drawing wherein:—

Figure 1 is a transverse section through a first embodiment of a conveyor belt according to the invention, and

Figure 2 is a view, to an enlarged scale, of one of the cords of the conveyor belt shown in Figure 1.

The conveyor belt 1 shown in Figure 1 is made from natural SBR rubber having a layer of reinforcement cords 2 embedded therein.

Each cord 2 extends longitudinally in the direction of the belt and adjacent cords are laterally spaced across the width of the belt with no weft component. Each cord 2 is made fron strands 3 of poly (p-phenylene terephthalamide). All the cords have the same direction of twist.

Manufacture of the belt 1 is as follows, individual strands each comprising 7 yarns of 167 tex of poly (p-phenylene terephthalamide) (Kevlar) are twisted together at 40 turns per metre and heat set at a temperature of 250°C for 1½ minutes under a tension of 9.0 grams per tex to increase the modulus of the strands. The strands are coated with an epoxy based adhesive subcoat (Aracast CY 350) which is activated at the temperature of the heat setting. Seven of the strands are twisted together at 25 turns per metre giving a 7×7/167 tex cord construction as shown in Figure 2. Individual cords having a diameter of 3.6 mm are then coated with an adhesive topcoat comprising a mixture of resorcinol, formaldehyde and latex while maintained under a tension of 3.0 grams per tex at a temperature of 230°C for 1½ minutes. The cords 2 are then arranged to form a layer of cords and two layers of curable natural SBR rubber are calendered onto the assembly and the belt construction is then cured in a press. The layer of cords is constructed so as to provide a spacing of 95 ends per metre across the width of the belt.

The above described belt has a tensile strength of 1100 Kg/cm per width of the belt.

The invention is not restricted to a conveyor belt having cords of the above described construction, for example cords of 7×7×2/167 tex, 7×7×3/167 tex and 7×7×5/167 tex or 7×4×250 tex construction may be used. Furthermore the spacing of the cords in the layer may be varied and more than one layer of similar or different cord constructions may be used depending on the strength requirements.

It will be appreciated that by appropriate selection of the cord construction and spacing of the cord belts having any desired tensile strength may be obtained. It is envisaged that the cord diameter should preferably be at least 2.0 mm giving a total cord tex of 2600 but cords of smaller diameter may be used particularly for low tensile strength belts where it may be advantageous to have a number of small diameter cords at a relatively close spacing as opposed to a fewer number of cords of larger diameter at a relatively large spacing.

Although it is preferred to use cords having the same direction of twist, cords having opposite directions of twist may be used and these may be arranged alternately or at random.

Additionally the assembly of the cords may be varied, for example the adhesive subcoat of the

strands may be omitted or the adhesive subcoat may be applied before or after the heat setting. Also the strands may be heat set without applying a predetermined degree of twist.

Furthermore the cords may be embedded in the natural SBR rubber by any known method. The natural SBR rubber may be replaced by any other suitable polymeric material e.g. a synthetic rubber such as neoprene or a suitable plastics material such as PVC to suit the required characteristics of the belt e.g. resistance to heat, oil, water or gas etc.

Finally a respective breaker layer of the type known to those skilled in the art e.g. made of a synthetic or natural yarn such as nylon or cotton or a conventional fabric weave may be provided on either side of the layer of cords.

CLAIMS

1. A conveyor belt comprising a layer of polymeric material reinforced by a plurality of cords of aromatic polyamide material extending longitudinally in the direction of the belt.

2. A conveyor belt according to claim 1 wherein the cords have the same direction of twist.

3. A conveyor belt according to claim 1 or claim 2 wherein the cords have been heat set.

4. A conveyor belt according to claim 1 or claim 2 wherein the cords are formed from strands which have been heat set prior to forming the cords.

5. A conveyor belt according to any one of the preceding claims wherein the cords have been coated with an adhesive topcoat.

6. A conveyor belt according to any one of the preceding claims wherein the cords are formed from strands which have been coated with an adhesive subcoat prior to forming the cords.

7. A conveyor belt according to any one of the preceding claims wherein the cords are arranged in one or more layers.

8. A conveyor belt according to claim 7 including a respective breaker layer on each side of the layer(s) of cords.

9. A conveyor belt according to any one of the preceding claims wherein the aromatic polyamide material comprises poly (p-phenylene terephthalamide) or poly (m-phenylene isophthalamide).

10. A conveyor belt according to any one of the preceding claims wherein the cords are laterally spaced relative to one another across the width of the belt.

11. A conveyor belt according to any one of the preceding claims wherein the cords have a minimum diameter of 2.0 mm.

12. A conveyor belt substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawing.

13. A method of making a conveyor belt comprising forming strands of an aromatic polyamide material, forming the strands into cords and uniting the cords in a polymeric material so that cords extend longitudinally in the direction of the belt.

14. A method according to claim 13 wherein the strands are formed of poly (p-phenylene terephthalamide) or poly (m-phenylene isophthalamide).

15. A method according to claim 13 or claim 14 including the step of heat setting the cords to increase the modulus of the cords.

16. A method according to claim 13 or claim 14 including the step of heat setting the strands to increase the modulus of the strands prior to forming the cords.

17. A method according to any one of claims 13 to 16 including the step of coating the cords with an adhesive topcoat prior to uniting the cords in the polymeric material.

18. A method according to claim 17 wherein the aromatic polyamide is poly (p-phenylene terephthalamide) and the strands are heat set under a tension of 9.0 grams per tex at a temperature of 250°C and the cords are maintained under a tension of 3.0 grams per tex at a temperature of 230°C whilst the adhesive topcoat is applied.

19. A method according to any one of claims 13 to 18 including the step of coating the strands with an adhesive subcoat prior to forming the strands into cords.

20. A method according to claim 19 and claim 16 wherein the adhesive subcoat is dried simultaneously with the heat setting of the strands.

21. A method according to claim 16 wherein the strands are heat set with a predetermined twist.

22. A method according to any one of claims 13 to 21 wherein the cords are arranged to form one or more layers of cords in which the cords in the or each layer are laterally spaced relative to one another across the width of the belt.

23. A method according to claim 22 wherein a respective breaker layer is arranged on either side of the layer(s) of cords.

24. A method according to any one of claims 13 to 23 wherein all the cords are arranged to have the same direction of twist.

25. A method according to any one of claims 13 to 24 wherein the cords are united in the polymeric material by calendering curable polymeric material onto the cords and subsequently curing the polymeric material.

26. A method of manufacturing a conveyor belt substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawing.

27. A conveyor belt manufactured by the method according to any one of claims 13 to 26.

28. A reinforcement for an article made of polymeric material comprises a cord of aromatic polyamide material in which the individual strands of the cord have been heat set to increase the modulus of the strands prior to forming the cord.

29. A method of forming a cord reinforcement made of an aromatic polyamide material comprises forming strands of the aromatic polyamide material, heat setting the strands to

increase the modulus of the strands and forming the strands into the cord.

30. A method according to claim 29 wherein the strands are coated wtih an adhesive subcoat prior to forming the cord.

31. A method according to claim 30 wherein the adhesive subcoat is dried simultaneously with the heat setting.

32. A method according to any one of claims 29 to 31 wherein the aromatic polyamide material is poly (p-phenylene terephthalamide) or poly (m-phenylene isophthalamide).

33. A method according to claim 32 wherein the aromatic polyamide is poly (p-phenylene terephthalamide) and the strands are heat set under a tension of 9.0 grams per tex at a temperature of 250°C.

34. A method according to any one of claims 29 to 33 wherein the strands are heat set with a predetermined twist.

35. A cord reinforcement made by the method of any one of claims 29 to 34.

36. An article of polymeric material reinforced by the cord reinforcement of claim 28 or claim 35.

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ABSTRACT:

CHG DATE=19990617 STATUS=O> A conveyor **belt** (1) made of polymeric material having a reinforcement comprising cords (2) of an aromatic **polyamide** extending longitudinally in the direction of the **belt** (1). The cords (2) comprise **strands which are twisted** or laid together. The cords (2) may be heat set to increase their modulus or the **strands** may be heat set prior to forming the cords (2) to increase the modulus of the **strands**. The cords (2) are coated with an adhesive topcoat and the **strands** may be coated with an adhesive subcoat prior to forming the cords (2). The **strands** may be heat set with a predetermined twist. The cords (2) in the **belt** (1) may all have the same direction of twist. <IMAGE>

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Abstract Text - FPAR (1):

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